IAP15 Rec'd PCT/PTO 30 JAN 2007

TRANSMITTAL FORM *(to be used for all correspondence after initial filing)*		Application No.	10/587,094
		Filing Date	July 20, 2006
		First Named Inventor	Eric Q. Li
		Art Unit	2121
		Examiner Name	
Total Number of Pages in This Submission		Attorney Docket Number	42P21656

ENCLOSURES *(check all that apply)*

- [x] Fee Transmittal Form
  - [ ] Fee Attached
- [ ] Amendment / Reply
  - [ ] After Final
  - [ ] Affidavits/declaration(s)
- [ ] Extension of Time Request
- [ ] Express Abandonment Request
- [ ] Information Disclosure Statement
  - [ ] PTO/SB/08
- [x] Certified Copy of Priority Document(s)
- [ ] Response to Missing Parts/ Incomplete Application
  - [ ] Basic Filing Fee
  - [ ] Declaration/POA
  - [ ] Response to Missing Parts under 37 CFR 1.52 or 1.53
- [ ] Drawing(s)
- [ ] Licensing-related Papers
- [ ] Petition
- [ ] Petition to Convert a Provisional Application
- [ ] Power of Attorney, Revocation Change of Correspondence Address
- [ ] Terminal Disclaimer
- [ ] Request for Refund
- [ ] CD, Number of CD(s)
  - [ ] Landscape Table on CD
- [ ] After Allowance Communication to TC
- [ ] Appeal Communication to Board of Appeals and Interferences
- [ ] Appeal Communication to TC (Appeal Notice, Brief, Reply Brief)
- [ ] Proprietary Information
- [ ] Status Letter
- [x] Other Enclosure(s) *(please identify below)*:

-Return postcard

Remarks

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm *or* Individual name	Paul A. Mendonsa, Reg. No. 42,879 BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP
Signature	Paul A. Mendonsa
Date	January 25, 2007

CERTIFICATE OF MAILING/TRANSMISSION

I hereby certify that this correspondence is being deposited with the United States Postal Service on the date shown below with sufficient postage as first class mail in an envelope addressed to: Mail Stop PCT, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

Typed or printed name	Katherine Jennings		
Signature	Katherine Jennings	Date	January 25, 2007

FEE TRANSMITTAL for FY 2006

Patent fees are subject to annual revision.

☐ Applicant claims small entity status. See 37 CFR 1.27.

TOTAL AMOUNT OF PAYMENT	($)

Complete if Known	
Application Number	10/587,094
Filing Date	July 20, 2006
First Named Inventor	Eric Q. Li
Examiner Name	
Art Unit	2121
Attorney Docket No.	42P21656

METHOD OF PAYMENT *(check all that apply)*

☐ Check ☐ Credit card ☐ Money Order ☒ None ☐ Other (please identify): ______

☒ Deposit Account Deposit Account Number: 02-2666 Deposit Account Name: Blakely, Sokoloff, Taylor & Zafman LLP

For the above-identified deposit account, the Director is hereby authorized to: (check all that apply)

☐ Charge fee(s) indicated below

☐ Charge fee(s) indicated below, except for the filing fee

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FEE CALCULATION

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
1051	130	2051	65	Surcharge - late filing fee or oath	
1052	50	2052	25	Surcharge - late provisional filing fee or cover sheet.	
2053	130	2053	130	Non-English specification	
1251	120	2251	60	Extension for reply within first month	
1252	450	2252	225	Extension for reply within second month	
1253	1,020	2253	510	Extension for reply within third month	
1254	1,590	2254	795	Extension for reply within fourth month	
1255	2,160	2255	1,080	Extension for reply within fifth month	
1401	500	2401	250	Notice of Appeal	
1402	500	2402	250	Filing a brief in support of an appeal	
1403	1,000	2403	500	Request for oral hearing	
1451	1,510	2451	1,510	Petition to institute a public use proceeding	
1460	130	2460	130	Petitions to the Commissioner	
1807	50	1807	50	Processing fee under 37 CFR 1.17(q)	
1806	180	1806	180	Submission of Information Disclosure Stmt	
1809	790	1809	395	Filing a submission after final rejection (37 CFR § 1.129(a))	
1810	790	2810	395	For each additional invention to be examined (37 CFR § 1.129(b))	

Other fee (specify) ______

SUBTOTAL (2) ($)

SUBMITTED BY Complete (if applicable)

Name (Print/Type)	Paul A. Mendonsa	Registration No. (Attorney/Agent)	42,879	Telephone	(503) 439-8778
Signature	Paul A. Mendonsa			Date	01/25/07

Based on PTO/SB/17 (12-04) as modified by Blakely, Sokoloff, Taylor & Zafman (wlr) 12/15/2004.
SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450

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证 明

CERTIFICATE

本证明之附件是向中国专利局作为受理局提交的下列国际申请副本
IS IS TO CERTIFY THAT ANNEXED HERETO IS A TRUE COPY OF THE BELOW IDENTIFIED INTERNATIONAL APPLICATION THAT WAS FILED WITH THE CHINESE PATENT OFFICE AS RECEIVING OFFICE

际申请号: PCT/CN2005/001242

RNATIONAL APPLICATION NUMBER

申请日: 11.8月 2005(11.08.2005)

NATILNAL FILING DATE

名 称: A RECURSIVE FEATURE ELIMINATING METHOD BASED ON A SUPPORT VECTOR

F INVENTION

BEST AVAILABLE COPY

CERTIFIED COPY OF
PRIORITY DOCUMENT

中华人民共和国国家知识产权局局长
COMMISSIONER OF THE STATE INTELLECTUAL PROPERTY OFFECE OF THE PEOPLE'S REPUBLIC OF CHINA

田力普

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REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

International Application No. PCT/CN 2005 / 0 0 1 2 4 2

11 · 8月 2005 (1 1 · 0 8 · 2 0 0 5)

International Filing Date

RO/CN 中华人民共和国国家知识产权局 PCT International Application

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference *(if desired) (12 characters maximum)* FPEL05150036

Box No. I TITLE OF INVENTION

A RECURSIVE FEATURE ELIMINATING METHOD BASED ON A SUPPORT VECTOR MACHINE

Box No. II APPLICANT ☐ This person is also inventor

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

INTEL CORPORATION
2200 Mission College Blvd.
Santa Clara, California 95052
United States of America

Telephone No.

Facsimile No.

Teleprinter No.

Applicant's registration No. with the Office

State *(that is, country)* of nationality: US

State *(that is, country)* of residence: US

This person is applicant for the purposes of: ☐ all designated States ☒ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

LI, Qiang
Room 3702, #4, North of Xibahe
Chaoyang District
Beijing, 100028
P. R. of China

This person is:
☐ applicant only
☒ applicant and inventor
☐ inventor only *(If this check-box is marked, do not fill in below.)*

Applicant's registration No. with the Office

State *(that is, country)* of nationality: CN

State *(that is, country)* of residence: CN

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

☒ Further applicants and/or (further) inventors are indicated on a continuation sheet.

Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as: ☒ agent ☐ common representative

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

China Patent Agent (H.K.) Ltd.
22/F, Great Eagle Centre
23 Harbour Road, Wanchai
Hong Kong Special Administrative Region
The People's Republic of China

Telephone No. (852)28284688

Facsimile No. (852)28271018

Teleprinter No.

Agent's registration No. with the Office

☐ **Address for correspondence:** Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

Sheet No. ...2...

Continuation of Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

If none of the following sub-boxes is used, this sheet should not be included in the request.

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*	This person is:
DIAO, Qian 6TH, Floor North Office Tower, #06-01 Beijing Kerry Centre 1, Guanghua Road Chao Yang District, Beijing 100020 P. R. of China	☐ applicant only ☒ applicant and inventor ☐ inventor only *(If this check-box is marked, do not fill in below.)* Applicant's registration No. with the Office
State *(that is, country)* of nationality: CN	State *(that is, country)* of residence: CN

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*	This person is:
	☐ applicant only ☐ applicant and inventor ☐ inventor only *(If this check-box is marked, do not fill in below.)* Applicant's registration No. with the Office
State *(that is, country)* of nationality:	State *(that is, country)* of residence:

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*	This person is:
	☐ applicant only ☐ applicant and inventor ☐ inventor only *(If this check-box is marked, do not fill in below.)* Applicant's registration No. with the Office
State *(that is, country)* of nationality:	State *(that is, country)* of residence:

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*	This person is:
	☐ applicant only ☐ applicant and inventor ☐ inventor only *(If this check-box is marked, do not fill in below.)* Applicant's registration No. with the Office
State *(that is, country)* of nationality:	State *(that is, country)* of residence:

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

☐ Further applicants and/or (further) inventors are indicated on another continuation sheet.

Sheet No. . . .3. . .

Box No. V DESIGNATIONS

The filing of this request constitutes under Rule 4.9(a), the designation of all Contracting States bound by the PCT on the international filing date, for the grant of every kind of protection available and, where applicable, for the grant of both regional and national patents.

However,

- ☐ DE Germany is not designated for any kind of national protection
- ☐ KR Republic of Korea is not designated for any kind of national protection
- ☐ RU Russian Federation is not designated for any kind of national protection

(The check-boxes above may be used to exclude (irrevocably) the designations concerned in order to avoid the ceasing of the effect, under the national law, of an earlier national application from which priority is claimed. See the Notes to Box No. V as to the consequences of such national law provisions in these and certain other States.)

Box No. VI PRIORITY CLAIM

The priority of the following earlier application(s) is hereby claimed:

Filing date of earlier application *(day/month/year)*	Number of earlier application	Where earlier application is:		
		national application: country or Member of WTO	regional application:* regional Office	international application: receiving Office
item (1)				
item (2)				
item (3)				

☐ Further priority claims are indicated in the Supplemental Box.

The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) *(only if the earlier application was filed with the Office which for the purposes of this international application is the receiving Office)* identified above as:

☐ all items ☐ item (1) ☐ item (2) ☐ item (3) ☐ other, see Supplemental Box

* *Where the earlier application is an ARIPO application, indicate at least one country party to the Paris Convention for the Protection of Industrial Property or one Member of the World Trade Organization for which that earlier application was filed (Rule 4.10(b)(ii)):* . . . .

. . . .

Box No. VII INTERNATIONAL SEARCHING AUTHORITY

Choice of International Searching Authority (ISA) *(if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used):*

ISA / CN . . . .

Request to use results of earlier search; reference to that search *(if an earlier search has been carried out by or requested from the International Searching Authority):*

Date *(day/month/year)* Number Country *(or regional Office)*

Box No. VIII DECLARATIONS

The following **declarations** are contained in Boxes Nos. VIII (i) to (v) *(mark the applicable check-boxes below and indicate in the right column the number of each type of declaration)*:

			Number of declarations
☐	Box No. VIII (i)	Declaration as to the identity of the inventor	:
☐	Box No. VIII (ii)	Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent	:
☐	Box No. VIII (iii)	Declaration as to the applicant's entitlement, as at the international filing date, to claim the priority of the earlier application	:
☐	Box No. VIII (iv)	Declaration of inventorship (only for the purposes of the designation of the United States of America)	:
☐	Box No. VIII (v)	Declaration as to non-prejudicial disclosures or exceptions to lack of novelty	:

Box No. IX CHECK LIST; LANGUAGE OF FILING

This international application contains:

(a) **in paper form**, the following number of sheets:

request (including declaration sheets)	:	4
description (excluding sequence listing and/or tables related thereto)	:	17
claims	:	6
abstract	:	1
drawings	:	4
Sub-total number of sheets	:	32
sequence listing	:	
tables related thereto	:	
(for both, actual number of sheets if filed in paper form, whether or not also filed in computer readable form; see (c) below)		
Total number of sheets	:	32

(b) ☐ **only in computer readable form** (Section 801(a)(i))
- (i) ☐ sequence listing
- (ii) ☐ tables related thereto

(c) ☐ **also in computer readable form** (Section 801(a)(ii))
- (i) ☐ sequence listing
- (ii) ☐ tables related thereto

Type and number of carriers (diskette, CD-ROM, CD-R or other) on which are contained the
- ☐ sequence listing: ....
- ☐ tables related thereto: ....

(additional copies to be indicated under items 9(ii) and/or 10(ii), in right column)

This international application is **accompanied by** the following item(s) *(mark the applicable check-boxes below and indicate in right column the number of each item)*:

		Number of items
1. ☒	fee calculation sheet	: 1
2. ☒	original separate power of attorney	: 1
3. ☐	original general power of attorney	:
4. ☐	copy of general power of attorney; reference number, if any:	:
5. ☐	statement explaining lack of signature	:
6. ☐	priority document(s) identified in Box No. VI as item(s):	:
7. ☐	translation of international application into *(language)*:	:
8. ☐	separate indications concerning deposited microorganism or other biological material	:
9. ☐	sequence listing in computer readable form *(indicate type and number of carriers)*	
(i) ☐	copy submitted for the purposes of international search under Rule 13*ter* only (and not as part of the international application)	:
(ii) ☐	*(only where check-box (b)(i) or (c)(i) is marked in left column)* additional copies including, where applicable, the copy for the purposes of international search under Rule 13*ter*	:
(iii) ☐	together with relevant statement as to the identity of the copy or copies with the sequence listing mentioned in left column	:
10. ☐	tables in computer readable form related to sequence listing *(indicate type and number of carriers)*	
(i) ☐	copy submitted for the purposes of international search under Section 802(b-*quater*) only (and not as part of the international application)	:
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(iii) ☐	together with relevant statement as to the identity of the copy or copies with the tables mentioned in left column	:
11. ☐	other *(specify)*:	:

Figure of the drawings which should accompany the abstract:

Language of filing of the international application: EN

Box No. X SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).

CHINA PATENT AGENT (H.K.) LIMITED 中国专利代理（香港）有限公司 专利申请专用章

For receiving Office use only

1. Date of actual receipt of the purported international application: 11 · 8月 2005 (11 · 08 · 2005)	2. Drawings: ☐ received: ☐ not received:
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:	
4. Date of timely receipt of the required corrections under PCT Article 11(2):	
5. International Searching Authority (if two or more are competent): ISA / — 6. ☐ Transmittal of search copy delayed until search fee is paid	

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Date of receipt of the record copy by the International Bureau:

This sheet is not part of and does not count as a sheet of the international application.

PCT

FEE CALCULATION SHEET

Annex to the Request

For receiving Office use only

International Application No. PCT/CN 2005 / 0 0 1 2 4 2

11 · 8月 2005 (1 1 · 0 8 · 2 0 0 5)

Date stamp of the receiving Office

Applicant's or agent's file reference FPEL05150036

Applicant
INTEL CORPORATION etc.

CALCULATION OF PRESCRIBED FEES

1. TRANSMITTAL FEE	CNY500	T	CNY500
2. SEARCH FEE	CNY1500	S	CNY1500

International search to be carried out by CN

(If two or more International Searching Authorities are competent to carry out the international search, indicate the name of the Authority which is chosen to carry out the international search.)

3. INTERNATIONAL FILING FEE

Where items (b) and/or (c) of Box No. IX apply, enter **Sub-total number of sheets**
Where items (b) and (c) of Box No. IX do not apply, enter **Total number of sheets** } 32

i1 first 30 sheets	CHF1400	i1	CHF1400
i2 2 (number of sheets in excess of 30) x CHF15 (fee per sheet) =	CHF30	i2	CHF30

i3 additional component (only if sequence listing and/or tables related thereto are filed in computer readable form under Section 801(a)(i), or both in that form and on paper, under Section 801(a)(ii)):

400 x ______ (fee per sheet) = ______ i3

Add amounts entered at i1, i2 and i3 and enter total at I ______ I

(Applicants from certain States are entitled to a reduction of 75% of the international filing fee. Where the applicant is (or all applicants are) so entitled, the total to be entered at I is 25% of the international filing fee.)

4. FEE FOR PRIORITY DOCUMENT *(if applicable)* ______ P

5. TOTAL FEES PAYABLE CNY2000CHF1430 TOTAL — CNY2000 CHF1430

Add amounts entered at T, S, I and P, and enter total in the TOTAL box

MODE OF PAYMENT

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- [ ] cash
- [ ] coupons
- [ ] cheque
- [ ] bank draft
- [ ] revenue stamps
- [ ] other *(specify)*:

AUTHORIZATION TO CHARGE (OR CREDIT) DEPOSIT ACCOUNT
(This mode of payment may not be available at all receiving Offices)

- [x] Authorization to charge the total fees indicated above.
- [x] *(This check-box may be marked only if the conditions for deposit accounts of the receiving Office so permit)* Authorization to charge any deficiency or credit any overpayment in the total fees indicated above.
- [x] Authorization to charge the fee for priority document.

Receiving Office: RO/ CN

Deposit Account No.:

Date: 08/10/2005

Name:

Signature:

PCT/CN 2005 / 0 0 1 2 4 2

A RECURSIVE FEATURE ELIMINATING METHOD BASED ON A SUPPORT VECTOR MACHINE

BACKGROUND

[0001] A recursive feature eliminating method based on a support vector machine (SVM-RFE) is widely used in data intensive applications, such as disease genes selection, structured data mining, and unstructured data mining, etc. The SVM-RFE method may comprise: SVM training an input training data to classify the training data, wherein the training data may comprise a plurality of training samples corresponding to a group of features and class labels associated with each of the training samples; eliminating at least one feature with a minimum ranking criterion from the group of features; and repeating the aforementioned SVM training and eliminating until the group becomes empty. The SVM-RFE may be used to rank the features, for example, to rank the genes that may cause a disease. Rounds of SVM training and eliminating are independent with each other.

BRIEF DESCRIPTION OF THE DRAWINGS

[0002] The invention described herein is illustrated by way of example and not by way of limitation in the accompanying figures. For simplicity and clarity of illustration, elements illustrated in the figures are not necessarily drawn to scale. For example, the dimensions of some elements may be exaggerated relative to other elements for clarity. Further, where considered appropriate, reference labels have been repeated among the figures to indicate corresponding or analogous elements.

[0003] Fig. 1 illustrates an embodiment of a computing system applying a SVM-RFE method.

[0004] Fig. 2 illustrates an embodiment of a SVM-RFE machine in the computing system of Fig. 1.

[0005] Fig. 3 illustrates an embodiment of a SVM-RFE method;

[0006] Fig. 4 illustrates an embodiment of a SVM training method involved in the SVM-RFE method of Fig. 3.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0007] The following description describes techniques for a recursive feature eliminating method based on a support vector machine. In the following description, numerous specific details such as logic implementations, pseudo-code, means to specify operands, resource partitioning/sharing/duplication implementations, types and interrelationships of system components, and logic partitioning/integration choices are set forth in order to provide a more thorough understanding of the current invention. However, the invention may be practiced without such specific details. In other instances, control structures, gate level circuits and full software instruction sequences have not been shown in detail in order not to obscure the invention. Those of ordinary skill in the art, with the included descriptions, will be able to implement appropriate functionality without undue experimentation.

[0008] References in the specification to “one embodiment”, “an embodiment”, “an example embodiment”, etc., indicate that the embodiment described may include a particular feature, structure, or characteristic, but every embodiment may not necessarily include the particular feature, structure, or characteristic. Moreover,

such phrases are not necessarily referring to the same embodiment. Further, when a particular feature, structure, or characteristic is described in connection with an embodiment, it is submitted that it is within the knowledge of one skilled in the art to effect such feature, structure, or characteristic in connection with other embodiments whether or not explicitly described.

[0009] Embodiments of the invention may be implemented in hardware, firmware, software, or any combination thereof. Embodiments of the invention may also be implemented as instructions stored on a machine-readable medium, that may be read and executed by one or more processors. A machine-readable medium may include any mechanism for storing or transmitting information in a form readable by a machine (e.g., a computing device). For example, a machine-readable medium may include read only memory (ROM); random access memory (RAM); magnetic disk storage media; optical storage media; flash memory devices; electrical, optical, acoustical or other forms of propagated signals (e.g., carrier waves, infrared signals, digital signals, etc.) and others.

[0010] Fig. 1 shows a computing system for implementing a recursive feature eliminating method based on a support vector machine (SVM-RFE). A non-exhausive list of examples for the computing system may include distributed computing systems, supercomputers, computing clusters, mainframe computers, mini-computers, client-server systems, personal computers, workstations, servers, portable computers, laptop computers and other devices for transceiving and processing data.

[0011] In an embodiment, the computing system 1 may comprise one or more processors 10, memory 11, chipset 12, I/O device 13, BIOS firmware 14 and the like. The one or more processors 10 are communicatively coupled to various

components (e.g., the memory 11) via one or more buses such as a processor bus as depicted in Fig. 1. The processors 10 may be implemented as an integrated circuit (IC) with one or more processing cores that may execute codes under a suitable architecture, for example, including Intel® Xeon™ MP architecture available from Intel Corporation of Santa Clara, California.

[0012] In an embodiment, the memory 12 may store codes to be executed by the processor 10. In an embodiment, the memory 12 may store training data 110, SVM-RFE 111 and operation system (OS) 112. A non-exhausive list of examples for the memory 102 may comprise one or a combination of the following semiconductor devices, such as synchronous dynamic random access memory (SDRAM) devices, RAMBUS dynamic random access memory (RDRAM) devices, double data rate (DDR) memory devices, static random access memory (SRAM), flash memory devices, and the like.

[0013] In an embodiment, the chipset 12 may provide one or more communicative path among the processor10, memory 11 and various components, such as the I/O device 13 and BIOS firmware 14. The chipset 12 may comprise a memory controller hub 120, an input/output controller hub 121 and a firmware hub 122.

[0014] In an embodiment, the memory controller hub 120 may provide a communication link to the processor bus that may connect with the processor 101 and to a suitable device such as the memory 11. The memory controller hub 120 may couple with the I/O controller hub 121, that may provide an interface to the I/O devices 13 or peripheral components (not shown in Fig. 1) for the computing system 1 such as a keyboard and a mouse. A non-exhaustive list of examples for the I/O devices 13 may comprise a network card, a storage device, a camera, a blue-tooth, an antenna, and the like. The I/O controller hub 121 may further

provide communication link to a graphic controller and an audio controller (not shown in Fig. 1). The graphic controller may control the display of information on a display device and the audio controller may control the display of information on an audio device.

[0015] In an embodiment, the memory controller hub 120 may communicatively couple with a firmware hub 122 via the input/output controller hub 121. The firmware hub 122 may couple with the BIOS firmware 14 that may store routines that the computing device 100 executes during system startup in order to initialize the processors 10, chipset 12, and other components of the computing device 1. Moreover, the BIOS firmware 14 may comprise routines or drivers that the computing device 1 may execute to communicate with one or more components of the computing device 1.

[0016] In an embodiment, the training data 110 may be input from a suitable devices, such as the I/O component 13, or the BIOS firmware. Examples for the training data 110 may comprise data collected for a feature selection/ranking task, such as gene expression data from a plurality of human beings or other species, or text data from web or other sources. The data format may be structured data, such as a database or table, or unstructured data, such as matrix or vector. The SVM-RFE 111 may be implemented between the training data 110 and the operation system 112. In an embodiment, the operation system 112 may include, but not limited to, different versions of LINUX, Microsoft Windows™ Server 2003, and real time operating systems such as VxWorks™, etc. In an embodiment, the SVM-RFE 111 may implement operations of: SVM training the training data 110 that corresponds to a group of features; eliminating at least one feature from the group according to a predetermined ranking criterion; and repeating the SVM

training and feature eliminating until the number of features in the group reaches a predetermined value, for example, until the group becomes empty, wherein the rounds of SVM training and eliminating dependent with each other. The SVM-RFE 111 may output a feature elimination history or a feature ranking list.

[0017] Other embodiments may implement other modifications or variations to the structure of the aforementioned computing system 1. For example, the SVM-RFE 111 may be implemented as an integrated circuit with various functional logics as depicted in Fig. 2. For another example, the memory 11 may further comprise a validation software (not show in Fig. 1) to validate the SVM-RFE classification by the SVM-RFE 111. More specifically, the validation software may determine whether a person has a disease by checking his/her gene expression with a gene ranking list output by the SVM-RFE 111.

[0018] An embodiment of the SVM-RFE 111 is shown in Fig. 2. As shown, the SVM-RFE 111 may comprise a decision logic 21, a SVM learning machine 22, a ranking criterion logic 23 and an eliminating logic 24.

[0019] In an embodiment, the training data 110 input to the SVM-RFE 111 may comprise a plurality of training samples $[x_1, x_2, \ldots, x_m]$ corresponding to a group of features, wherein m represents the number of training samples. The training data may further comprise class labels associated with each of the training samples $[y_1, y_2, \ldots, y_m]$. In an embodiment, each of the training samples represents a vector of n dimensions, wherein each dimension corresponds with each feature, and each of the class labels has a number of values. For example, if the training data is gene data collected from a plurality of persons, each of the training samples represents a pattern of n gene expression coefficients for one person, and each of the class labels has two values (i.e., [1, -1]) to represent two-class classification of its

associated training sample, e.g., whether the person has a certain decease ($y_i = 1$) or not ($y_i = -1$).

[0020] In an embodiment, the decision logic 21 may determine whether the group is empty and output a feature ranking list or feature elimination history if so. However, if the group is not empty, the SVM learning machine 22 may train the training data by setting a normal to a hyperplane where the training data may be mapped to leave the largest possible margin on either side of the normal. The SVM learning machine 22 may comprise a linear SVM learning machine and non-linear SVM learning machine. In an embodiment for linear SVM learning machine, a normal may comprise a vector ($\vec{\omega}$) representing a linear combination of the training data. For non-linear SVM learning machine, a normal may comprise a vector ($\vec{\omega}$) representing a non-linear combination of the training data. Each component of the vector represents a weight for each feature in the group of features.

[0021] In an embodiment, the ranking criterion logic 23 may compute a predetermined ranking criterion for each feature based upon the weight vector $\vec{\omega}$. The eliminating logic 27 may eliminate at least one feature with a certain ranking criterion from the group of features, for example, the at least one feature with a minimum or maximum ranking criterion in the group of features. Then, the decision logic 21 may determine whether the group becomes empty. If not, then in another round of SVM training and feature eliminating, the SVM learning machine 22 will retrain the training data corresponding to the group of features without the eliminated ones, the ranking criterion logic 23 and eliminating logic 24 may

compute the predetermined ranking criterion for each features in the group and eliminate at least one features with a minimum ranking criterion from the group of features. The SVM-RFE 111 may repeat the rounds of SVM training and feature eliminating as described above until the group becomes empty.

[0022] In an embodiment, the SVM learning machine 22 may comprise a kernel data logic 220, a buffer 221, a Lagrange multiplier logic 222 and a weight logic 223. In a first round of SVM training, the kernel data logic 22 may compute the kernel data based on the training data corresponding to the group of features and store the kernel data in the buffer 22 and then in each round of SVM training later, the kernel data logic 220 may retrieve a kernel data from the buffer 23, update the kernel data based on a part of the training data corresponding to the at least one feature that may be eliminated in a previous round and store the updated kernel data in the buffer in place of the old one.

[0023] In an embodiment, the Lagrange multiplier logic 222 may compute a Lagrange multiplier α_i for each of the training samples by utilizing the kernel data output from the kernel data logic 220 and the weight logic 224 may obtain a weight ω_k for each feature in the group of features, wherein i is an integer in a range of [1, the number of training samples], and k is an integer in a range of [1, the number of features].

[0024] Fig. 3 depicts an embodiment of a SVM-RFE method that may be implemented by the SVM-RFE 111.

[0025] As depicted, the SVM-RFE 111 may input the training data 110 in block 301. In an embodiment, the training data may comprise a plurality of training samples $[x_1, x_2, \ldots, x_m]$, wherein m represents the number of training samples. The training data may further comprise class labels associated with each of the

training samples $[y_1, y_2, \ldots, y_m]$. Each of the training samples may represent a vector of n dimensions, wherein each dimension corresponds to each feature in a group of features (hereinafter, the group is labeled as group G), and each of class labels has a number of values to represent the class that its associated training sample belongs to.

[0026] In block 302, the decision logic 21 of SVM-RFE 111 may determine whether the number of features in the group G is zero (block 301). If the number of features in the group G is greater than zero, then the SVM learning machine 22 of SVM-RFE 111 may train the training data corresponding to the features in the group G, so as to obtain a vector ($\vec{\omega}$) for the training data (block 303). Each component of the weight vector represents a weight (e.g., weight (ω_k)) for a feature (e.g., the k^{th} feature) in the group G.

[0027] Then, the ranking criterion logic 23 may compute a ranking criterion for each feature in the group G based on its weight in block 304. In an embodiment, the ranking criterion is a square of the weight, e.g., $c_k = (\omega_k)^2$, wherein c_k represents the ranking criterion for the k^{th} feature. However, in other embodiments, the ranking criterion may be obtained in other ways.

[0028] In block 305, the eliminating logic 24 may eliminate at least one feature with a certain ranking criterion from the group G. In an embodiment, the at least one feature (e.g., the k^{th} feature) may correspond to the ranking criterion (e.g., $c_k = (\omega_k)^2$) that is the minimum in the group G. In another embodiment, the at least one feature may correspond to the ranking criterion that is the maximum in the group G. In other embodiments, the at least one feature may be eliminated in other ways.

[0029] In block 306, the eliminating logic 24 of the SVM-RFE 111 or other suitable logics may optionally update the training data by removing a part of the training data that corresponds to the eliminated features. In an embodiment that the input training data may comprise m training samples and m class labels associated with the training samples, and each of the training samples is a vector of n dimensions wherein each dimension corresponds to each feature of the group G, the updated training data may comprise m training samples and m class labels associated with the training samples, and each of the training samples is a vector of (n-p) dimensions wherein (n-p) represents the number of the features in the group G after p features may be eliminated in block 305.

[0030] In block 307, the eliminating logic 24 of the SVM-RFE 111 or other suitable logics may record the eliminating history, or record the feature ranking list based on the eliminating history. In an embodiment, the at least one features eliminated in block 305 may be listed as a least important feature in the feature ranking list. In another embodiment, the at least features may be listed as a most important feature in the feature ranking list.

[0031] Then, the decision logic 21 of the SVM-RFE 111 may continue to determine whether the number of features in the group G is zero in block 302. If not, the round of SVM training and feature eliminating as described with reference to blocks 303-307 may be repeated until the group G is determined to be empty, namely, the number of features therein is zero.

[0032] If the decision logic 21 determines the number of features in the group G is zero in block 302, then the decision logic 21 or other suitable logics of SVM-RFE 111 may output the eliminating history or the feature ranking list.

[0033] Fig. 4 depicts an embodiment of SVM training implemented by the SVM learning machine 22 in block 303 of Fig. 3. In the embodiment, blocks depicted in Fig. 4 may be implemented in each round of SVM training and feature elimination.

[0034] As depicted, the kernel data logic 220 of the SVM learning machine or other suitable logics may determine whether it is the first round of SVM training for the training data 110 (block 401). This determination may be accomplished by setting a count number. If it is the first round of SVM training, then the kernel data logic 220 may compute a kernel data based on the training data 110 in block 402. In an embodiment for linear SVM training, the kernel data may be computed by the following equations (1) and (2):

$$K^{round1} = \begin{bmatrix} k_{1,1}^{round1} \ldots\ldots\ldots\ldots k_{1,m}^{round1} \\ \ldots\ldots\ldots\ldots k_{i,j}^{round1} \ldots\ldots\ldots\ldots \\ k_{m,1}^{round1} \ldots\ldots\ldots k_{m,m}^{round1} \end{bmatrix} \quad (1)$$

$$k_{ij}^{round1} = x_i^T x_j = \sum_{k=1}^{n} x_{ik} x_{jk} \quad (2)$$

wherein, K^{round1} is the kernel data of a matrix with $(m \cdot m)$ components k_{ij}^{round1}, m represents the number of training samples, x_i^T represents a transpose of i^{th} training sample that is a vector of n components, x_j represents j^{th} training sample that is another vector of n components, n represents the number of features in the group G. Other embodiments may implement other modifications and variations to block 406. For example, for non-linear SVM training, the kernel data may be obtained in a different way, e.g., the Gaussian RBF kernel:

$$k_{i,j}^{round} = e^{-\|x_i - x_j\|^2 / 2\sigma^2} \quad (3).$$

[0035] Then, the kernel data logic 220 stores the kernel data in the buffer 221 of the SVM learning machine 22 in block 403. The Lagrange multiplier logic 222 may compute a Lagrange multiplier matrix based upon the kernel data in blocks 408-412 and the weight logic 223 may compute a weight vector based on the Lagrange multiplier matrix in block 414. With these implementations, the first round of SVM training for the training data 110 is completed.

[0036] However, if the kernel data logic 220 or other suitable logics determines that it is not the first round of SVM training for the training data 110 in block 401, then in block 404, the kernel data logic 220 or other suitable logics may input the at least one feature eliminated in a previous round of feature elimination implemented in block 305 of Fig. 3. For example, if it is q^{th} round of SVM training ($q>1$), then the kernel data logic or other suitable logics may input the at least one feature eliminated in a $(q-1)^{th}$ round of feature elimination (e.g., the p^{th} feature that is eliminated from the group of n features in the $(q-1)^{th}$ round of feature elimination). Then, the kernel data logic 220 may retrieve the kernel data stored in the buffer 221 in a previous round of SVM training (block 405), and update the kernel data based on a part of the training data corresponding to the at least one eliminated feature (block 406). In an embodiment for linear SVM training, the kernel data may be updated by the following equations (4) and (5):

$$K^{round(q)} = \begin{bmatrix} k_{1,1}^{round(q)} \dots\dots\dots k_{1,m}^{round(q)} \\ \dots\dots\dots\dots k_{i,j}^{round(q)} \dots\dots\dots \\ k_{m,1}^{round(q)} \dots\dots\dots k_{m,m}^{round(q)} \end{bmatrix} \tag{4}$$

$$k_{ij}^{round(q)} = k_{ij}^{round(q-1)} - x_{ip} x_{jp} \tag{5}$$

wherein, $k_{ij}^{round(q)}$ represents a component of the kernel data K in q^{th} round of SVM training, $k_{ij}^{round(q-1)}$ represents a component of the kernel data K in a $(q-1)^{th}$ round of SVM training, x_{ip} represents the i^{th} training sample with p^{th} feature that is eliminated in $(q-1)^{th}$ round of feature elimination, x_{jp} represents the j^{th} training sample with p^{th} feature that is eliminated in $(q-1)^{th}$ round of feature elimination.

[0037] Other embodiments may implement other modifications and variations to block 406. For example, for non-linear SVM training, the kernel data may be updated in a different way, e.g., for the Gaussian RBF kernel, a component for the kernel data K in q^{th} round may be updated by

$$k_{ij}^{round(q)} = k_{ij}^{round(q-1)} \times e^{-(x_{ip} - x_{jp})^2 / 2\sigma^2} \qquad (6).$$

[0038] Then, in block 407, the kernel data logic 220 may replace the kernel data in the buffer 221 with the updated kernel data obtained in block 406. The Lagrange multiplier logic 222 may compute a Lagrange multiplier matrix based on the kernel data in blocks 408-412 and the weight logic 223 may compute a weight vector based on the Lagrange multiplier matrix in block 414. With these implementations, the q^{th} round of SVM training is completed.

[0039] More specifically, in block 408, the Lagrange multiplier logic 222 may initialize a Lagrange multiplier matrix α in each round of SVM training, wherein each component of the α matrix represents a Lagrange multiplier (e.g. α_i) corresponding to a training sample x_i. In an embodiment, the initialization of the Lagrange multiplier matrix may be implemented by setting a predetermined value (e.g., zero) to each component of the Lagrange multiplier matrix.

[0040] Then, in block 409, the Lagrange multiplier logic 222 may determine whether each of the Lagrange multipliers corresponding to each of the training samples (e.g., [α_1, α_2,...., α_m]) fulfill the Karush-Kuhn-Tucker (KKT) conditions. More specifically, whether each of the Lagrange multipliers fulfills the following five conditions:

1. $\frac{\partial}{\partial w_v} L(w,b,\alpha) = w_v - \sum_{i=1}^{m} \alpha_i y_i x_{iv}$ $\qquad v = 1,.....,n$

2. $\frac{\partial}{\partial b} L(w,b,\alpha) = -\sum_{i} \alpha_i y_i = 0$

3. $y_i(x_i \cdot w - b) - 1 \geq 0$ $\qquad i = 1,......,m$

4. $\alpha_i \geq 0$ $\qquad \forall i$

5. $\alpha_i(y_i(x_i \cdot w - b) - 1) = 0$

wherein, w_v represents the weight for the v^{th} feature, b represents a bias value, $L(w,b,\alpha)$ represents a Lagrangian with w,b and α as variables:

$$L(w,b,\alpha) = \frac{1}{2}\langle w \cdot w \rangle - \sum_{i=1}^{m} \alpha_i [y_i(\langle w \cdot x_i \rangle + b) - 1] \tag{7}$$

[0041] If not all of the Lagrange multipliers fulfill the KKT conditions, the Lagrange multiplier logic 222 may initialize an active set for two Lagrange multipliers in block 410. In an embodiment, the initialization of the active set may be implemented by clearing a data fragment in a memory of the computing system to store the active set. In other embodiments, the active set may be initialized in other ways.

[0042] Then, in block 411, the Lagrange multiplier logic 222 may select two Lagrange multipliers (e.g., α_1 and α_2) as an active set with heuristics, wherein the two Lagrange multiplier violates the KKT conditions with minimum errors (e.g.,

errors E_1 and E_2 respectively associated with the two Lagrange multipliers α_1 and α_2) under a predetermined constraint. In order to do that, the Lagrange multiplier logic 222 may obtain the errors associated with each of the Lagrange multipliers (e.g., [$\alpha_1, \alpha_2, \ldots, \alpha_m$]) by utilizing the kernel data stored in the buffer 221. In an embodiment for linear SVM training, the predetermined constraint may comprise $0 \le \alpha_i \le C$ wherein C is a predetermined value, and the error associated with each Lagrange multiplier may be obtained by the following equation and then stored in an error cache:

$$E_j = \left(\sum_{i=1}^{m} \alpha_i y_i k_{ij}^{round(q)} - y_j \right) \qquad j = 1, \ldots\ldots, m \tag{8}$$

wherein, E_j represents an error associated with a Lagrange multiplier α_j in q[th] round of SVM training, $k_{ij}^{round(q)}$ may be obtained from the kernel data stored in the buffer 221. Other embodiments may implement other modifications and variations to block 411. For example, the active set may comprise the number of Lagrange multipliers other than two.

[0043] Then, in block 412, the Lagrange multiplier logic 222 may update the Lagrange multipliers in the active set by utilizing the kernel data K stored in the buffer 221. In an embodiment that the SVM learning machine is a linear learning machine and the active set may comprise two Lagrange multipliers (e.g., α_1 and α_2), the Lagrange multiplers may be updated with the following equations:

$$\alpha_2^{new} = \alpha_2 + \frac{y_2(E_2 - E_1)}{\eta}, \quad \eta \equiv 2k_{12} - k_{11} - k_{22}, \quad E_j = \left(\sum_{i=1}^{m} \alpha_i y_i k_{ij}^{round(q)} - y_j \right) - y_j \tag{9}$$

$$\alpha_2^{new,clipped} = \begin{cases} H & if \quad \alpha_2^{new} \geq H \\ \alpha_2^{new} & if \quad L < \alpha_2^{new} < H \\ L & if \quad \alpha_2^{new} \leq L \end{cases} \tag{10}$$

$$L = \max(0, \alpha_2 - \alpha_1), \qquad H = \min(C, C + \alpha_2 - \alpha_1) \tag{11}$$

$$\alpha_1^{new} = \alpha_1 + s(\alpha_2 - \alpha_2^{new,clipped}), s = y_1 y_2 \tag{12}$$

[0044] However, other embodiments may implement other modifications and variations to block 412.

[0045] Then, in block 413, the Lagrange multiplier logic 222 may update the error cache by computing the errors associated with the updated Lagrange multipliers in the active set with the equation (8).

[0046] Then, the Lagrange multiplier logic 222 may continue to update other Lagrange multipliers in the Lagrange multiplier matrix in blocks 408-413, until all of the Lagrange multipliers in the matrix fulfill KKT conditions.

[0047] Then, the weight logic 223 may compute the weight vector ($\vec{\omega}$) based on the Lagrange multipliers obtained in blocks 408-413, wherein each component of the vector corresponds to each of the feature. In an embodiment for linear SVM training, weight for each feature may be obtained with the following equation:

$$w_k = \sum_{i=1}^{m} \alpha_i y_i x_{ik} \tag{13}$$

wherein, w_k represents a weight for k^{th} feature, m represent the number of the training samples, x_{ik} represents the training samples corresponding to the

k^{th} feature. However, other embodiments may implement other modifications and variations to block 414.

[0048] Although the present invention has been described in conjunction with certain embodiments, it shall be understood that modifications and variations may be resorted to without departing from the spirit and scope of the invention as those skilled in the art readily understand. Such modifications and variations are considered to be within the scope of the invention and the appended claims.

What is claimed is:

1. A method, comprising

determining a value for each feature in a group of features provided by a training data;

eliminating at least one feature from the group by utilizing the value for each feature in the group;

updating the value for each feature in the group based on a part of the training data that corresponds to the eliminated feature.

2. The method of claim 1, wherein the training data further comprises a plurality of training samples, each of the training samples corresponding to the group of features.

3. The method of claim 1, wherein determining the value comprises:

computing a kernel data based on the training data;

computing the value for each feature of the group based on the kernel data; and

storing the kernel data in a buffer.

4. The method of claim 3, wherein computing the kernel data further comprises computing a matrix as the kernel data, each component of the matrix comprising a dot product of two of training samples provided by the training data.

5. The method of claims 1, wherein updating the value further comprises:

retrieving a kernel data from a buffer;

updating the kernel data based on the part of the training data that corresponds to the eliminated features; and

updating the value for each feature of the group based on the updated kernel data.

6. The method of claim 5, wherein updating the kernel data further comprises:

subtracting a matrix from the kernel data, each component of the matrix comprising a dot product of two of training samples provided by the part of the training data.

7. The method of claim 1, wherein eliminating at least one feature comprises:

computing a ranking criterion for each feature of the group based on the value for the each feature;

eliminating the at least one feature with the minimum ranking criterion from the group; and

recording the eliminated feature in a feature ranking list.

8. The method of claim 1, further comprising:

repeating of eliminating the at least one feature from the group and updating the value for each feature of the group until a number of features in the group reaches a predetermined value.

9. An apparatus, comprising:

a training logic to determine a value for each feature in a group of features provided by a training data; and

an eliminate logic to eliminate at least one feature from the group by utilizing the value for each feature in the group,

wherein the training logic further updates the value for each feature in the group based on a part of the training data that corresponds to the eliminated feature.

10. The apparatus of claim 9, wherein the training data comprises a plurality of training samples, each of the training samples having the group of features.

11. The apparatus of claim 9, further comprising:

a decision logic to decide whether to repeat the elimination of the at least one features from the group and update of the value for each feature of the group until a number of features in the group reaches a predetermined value.

12. The apparatus of claim 9, wherein the training logic further comprises:

a kernel data logic to compute a kernel data based upon the training data;

a buffer to store a kernel data;

a value logic to compute the value based on the kernel data.

13. The apparatus of claim 12, wherein the kernel data logic further updates the kernel data in the buffer based on the part of the training data that

corresponds to the eliminated features, and the value logic further updates the value based upon the updated kernel data.

14. The apparatus of claim 12, wherein the kernel data logic further subtracts a matrix from the kernel data, each component of the matrix comprising a dot product of two of training samples provided by the part of the training data.

15. The apparatus of claim 9, wherein the eliminate logic further comprises a ranking criterion logic to compute a ranking criterion for each feature of the group based on the value for the each feature.

16. The apparatus of claim 9, wherein the eliminate logic further comprises a feature eliminate logic to eliminate the at least one feature having the minimum ranking criterion from the group.

17. A machine-readable medium comprising a plurality of instructions, that in response to being executed, result in a computing system:

determining a value for each feature in a group of features provided by a training data;

eliminating at least one feature from the group by utilizing the value for each feature in the group; and

updating the value for each feature in the group based on a part of the training data that corresponds to the eliminated feature.

18. The machine-readable medium of claim 17, wherein the training data further comprises a plurality of training samples, each of the training samples corresponding to the group of features.

19. The machine-readable of claim 17, wherein the plurality of instructions that result in the computing system determining the value, further result in the computing system:

computing a kernel data based on the training data;

computing the value for each feature of the group based on the kernel data; and

storing the kernel data in a buffer.

20. The machine-readable of claim 19, wherein the plurality of instructions that result in the computing system computing the kernel data, further result in the computing system computing a matrix as the kernel data, each component of the matrix comprising a dot product of two of training samples provided by the training data.

21. The machine-readable of claim 17, wherein the plurality of instructions that result in the computing system updating the value, further result in the computing system:

retrieving a kernel data from a buffer;

updating the kernel data based on the part of the training data that corresponds to the eliminated feature; and

updating the value for each feature of the group based on the updated kernel data.

22. The machine-readable of claim 21, wherein the plurality of instructions that result in the computing system updating the kernel data, further result in the computing system:

subtracting a matrix from the kernel data, each component of the matrix comprising a dot product of two of training samples provided by the part of the training data that corresponds to the eliminated feature.

23. The machine-readable of claim 17, wherein the plurality of instructions that result in the computing system eliminating at least one feature, further result in the computing system:

computing a ranking criterion for each feature of the group based on the value for the each feature;

eliminating the at least feature with the minimum ranking criterion from the group; and

recording the eliminated feature in a feature ranking list.

24. The machine-readable of claim 17, wherein the plurality of instructions further result in the computing system:

repeating of eliminating the at least feature from the group and updating the value for each feature of the group until a number of features in the group reaches a predetermined value.

ABSTRACT

Method, apparatus and system are described to perform a feature eliminating method based on a support vector machine. In some embodiments, a value for each feature in a group of features provided by a training data is determined. At least one feature is eliminated from the group by utilizing the value for each feature in the group. The value for each feature in the group is updated based upon a part of the training data that corresponds to the eliminated feature.

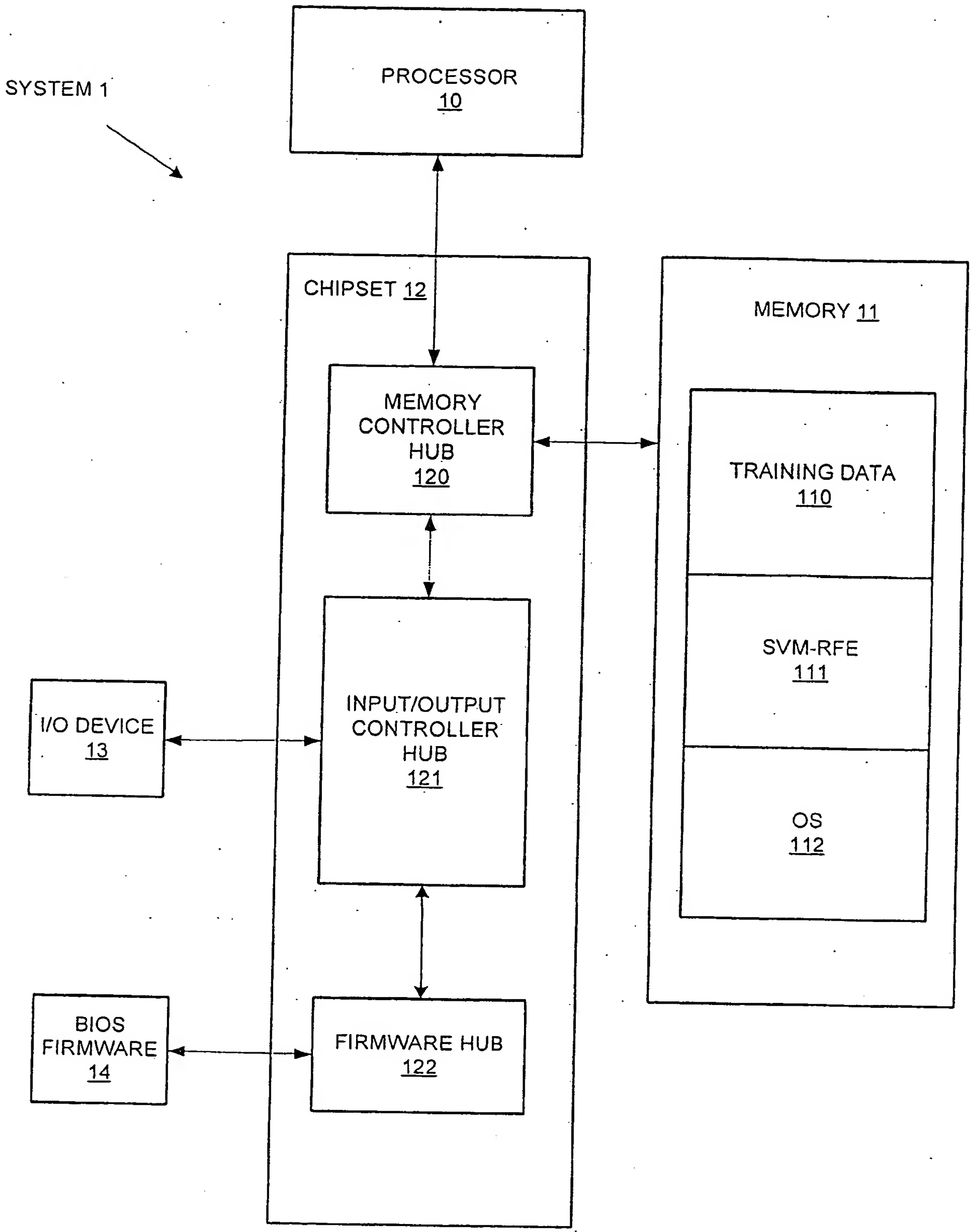

SYSTEM 1
PROCESSOR
10
CHIPSET 12
MEMORY
CONTROLLER
HUB
120
INPUT/OUTPUT
CONTROLLER
HUB
121
FIRMWARE HUB
122
MEMORY 11
TRAINING DATA
110
SVM-RFE
111
OS
112
I/O DEVICE
13
BIOS
FIRMWARE
14

FIG. 1

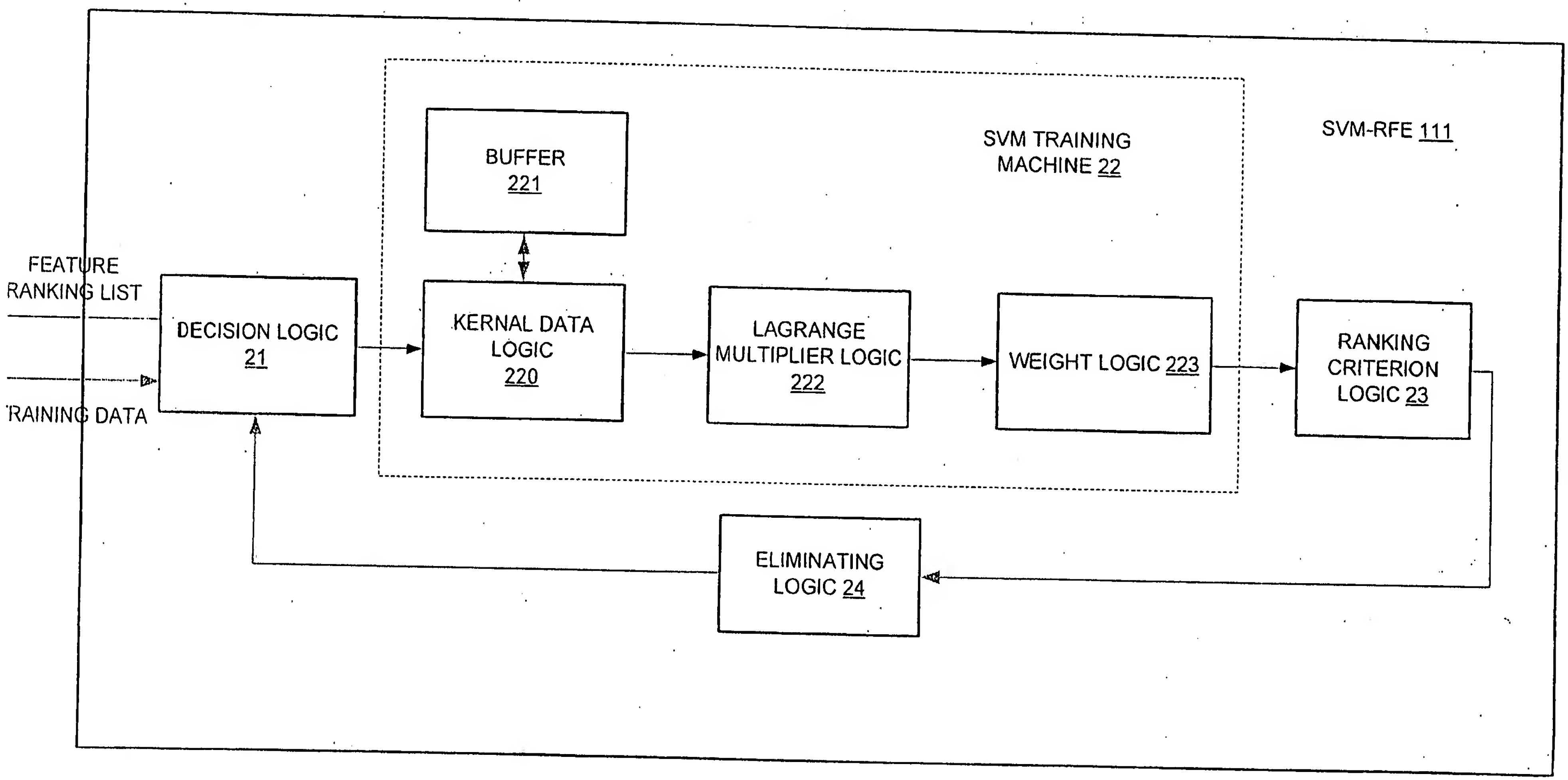

SVM-RFE 111
SVM TRAINING MACHINE 22
BUFFER 221
FEATURE RANKING LIST
TRAINING DATA
DECISION LOGIC 21
KERNAL DATA LOGIC 220
LAGRANGE MULTIPLIER LOGIC 222
WEIGHT LOGIC 223
RANKING CRITERION LOGIC 23
ELIMINATING LOGIC 24

FIG. 2

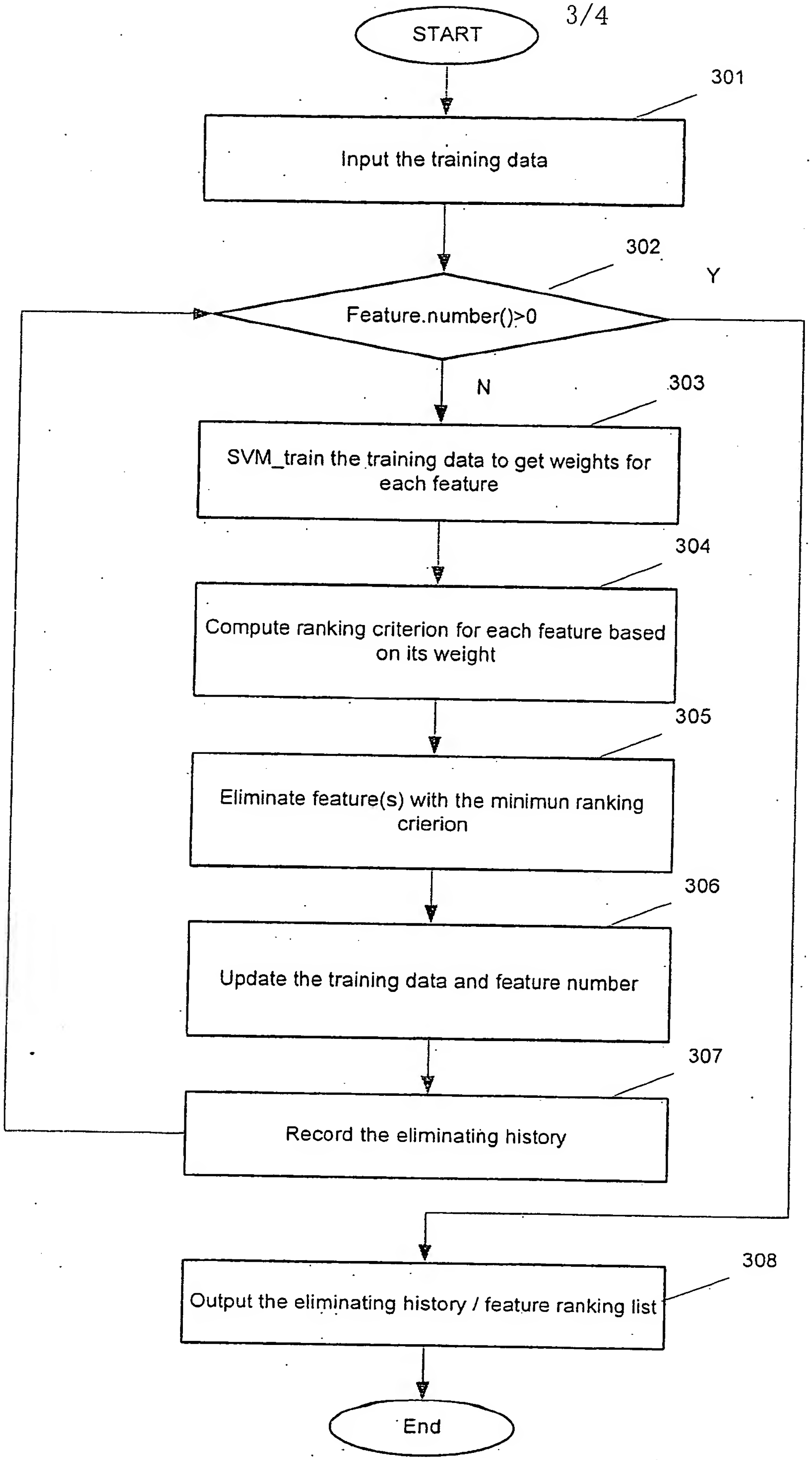
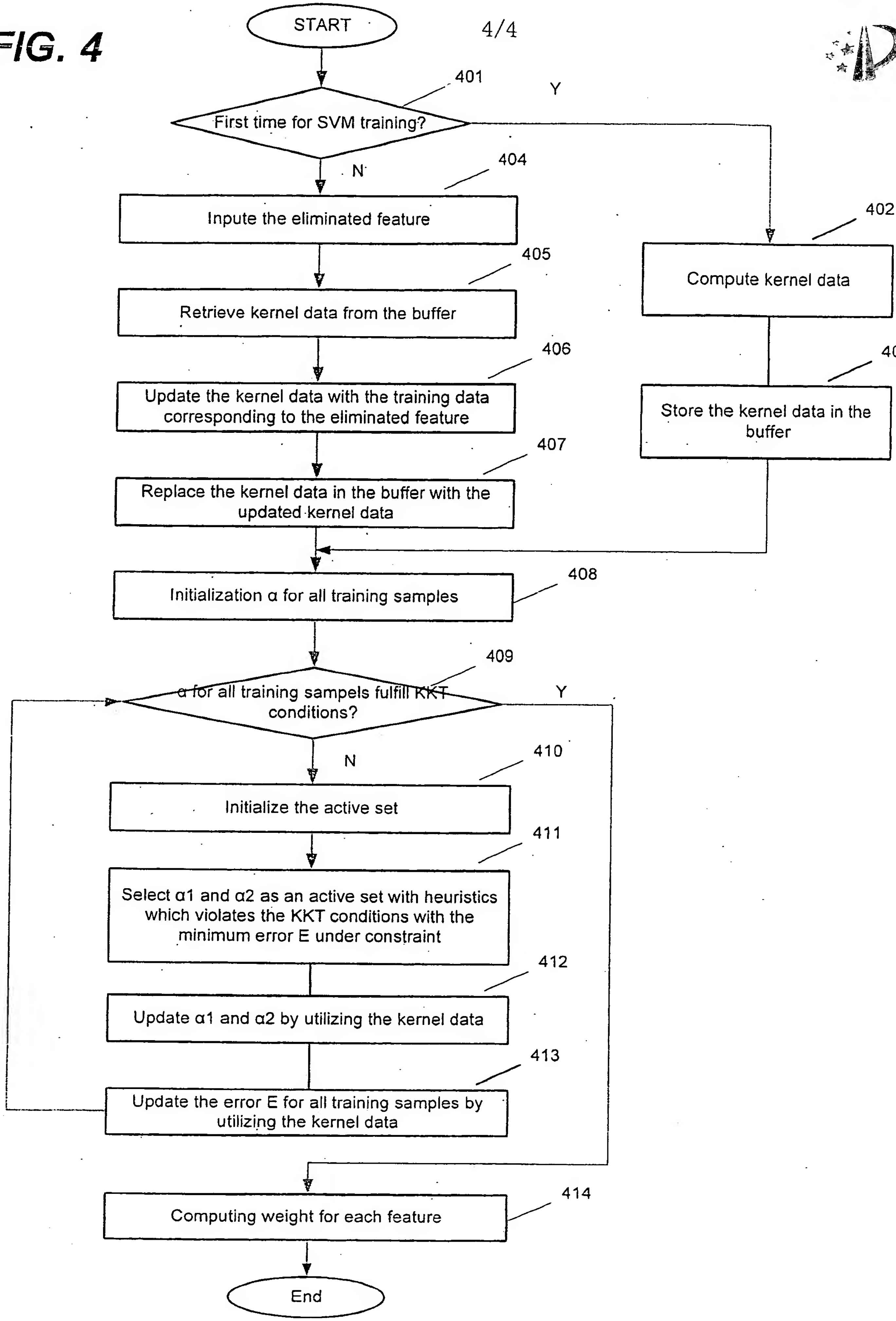

START
301
Input the training data
302
Y
Feature.number()>0
N
303
SVM_train the training data to get weights for each feature
304
Compute ranking criterion for each feature based on its weight
305
Eliminate feature(s) with the minimun ranking crierion
306
Update the training data and feature number
307
Record the eliminating history
308
Output the eliminating history / feature ranking list
End

FIG. 3

FIG. 4


START
401
First time for SVM training?
Y
N
404
Inpute the eliminated feature
405
Retrieve kernel data from the buffer
406
Update the kernel data with the training data corresponding to the eliminated feature
407
Replace the kernel data in the buffer with the updated kernel data
402
Compute kernel data
403
Store the kernel data in the buffer
408
Initialization α for all training samples
409
α for all training sampels fulfill KKT conditions?
Y
N
410
Initialize the active set
411
Select α1 and α2 as an active set with heuristics which violates the KKT conditions with the minimum error E under constraint
412
Update α1 and α2 by utilizing the kernel data
413
Update the error E for all training samples by utilizing the kernel data
414
Computing weight for each feature
End